

**BEST AVAILABLE COPY****REMARKS**

Claims 2, 3, 5-6 and 9-10 are cancelled. Claims 1 and 7 are amended. Support for amended claim 1 may be found at page 3 lines 19-22, page 9 lines 8-10 and the claims as originally filed. Claim 7 is amended to conform dependency to the claims as amended. No new matter is added by the amendments. Claims 1, 4, 7, 8 and 11 remain in the application.

Claim 1 is rejected under 35 U.S.C. §102(b) as being anticipated by Murnick (US 5,394,236). Applicants traverse the rejection to the extent that it may be maintained.

Briefly, applicants' invention relates to a spectroscopic method for analyzing isotope constituents in carbon dioxide gas samples using a reference gas having two absorption wavelengths close to the absorption wavelengths of the isotopes. Absorption wavelengths of the reference gas are used to identify absorption wavelengths of the isotopes for analysis. In particular, a semi-conductor laser (LD) emitting infrared energy in a 2000 nm wavelength band is used to obtain the absorption spectra of a gas sample containing an analyte having isotopes. The absorption spectra of a reference gas different from the analyte is also obtained. A positional relationship is determined between the absorption spectra of the reference gas and the isotopes to be analyzed (analyte). Wavelengths of the absorption spectra of the isotopes for analysis are calculated from the values for the wavelengths of the reference gas, the values of the driving currents of the LD associated with the wave lengths of the reference gas and the rate of change of the wavelengths of the reference gas with respect to the associated driving currents (page 10 line 18 to page 11 line 12). Having precisely identified absorption wavelengths of the analyte isotopes, the abundance ratios and concentrations of the isotopes are determined by conventional calculations (page 11 line 22 to page 12 line 7). The steps of the method are describe in greater detail at pages 10-12, and an embodiment using hydrogen bromide as a reference gas is described at pages 12-17 of the specification. However, other substances such as water and nitrogen oxide are also suitable reference gases (page 9 line 8-10).

In sharp contrast, Murnick directly measures the isotopic content of a gas sample containing carbon dioxide without the use of a reference gas. The isotopic species in the analyte sample are maintained in an excited state by means of an inductive coil surrounding a gas sample cell. A light beam having a wavelength corresponding to the transition energy of the excited

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isotope-bearing species is applied to the analyte sample. The response is measured by observing the optogalvanic effect (column 3 line 58 to column 4 line 64). Murnick discloses a gas laser comprising carbon dioxide having an abnormally high proportion of  $^{13}\text{C}$  to provide a light beam having wavelengths corresponding to the transition energy of each excited state (column 8 lines 54 to column 9 line 26). The CO<sub>2</sub> laser is not a reference gas but a source of light having a very precise wavelength. If a different light source such as tunable dye laser is used, a reference cell containing a known sample of the isotope bearing species, i.e. carbon dioxide, is used as a means to tune the frequency of the laser to the transition energy of the excited state (column 14 lines 26-54). The reference gas is not used to identify absorbance wavelengths of the isotopes for analysis. Murnick chooses the reference gas to correspond to the analyte gas for the purpose of tuning the laser light source. Applicants respectfully submit that Murnick does not anticipate their invention as claimed and request Examiner to withdraw the rejection on this ground.

Claim 1 is rejected under 35 U.S.C. §102(b) as being anticipated by Sauke et al. (US 5,640,014). Applicants traverse the rejection to the extent that it may be maintained.

Sauke et al. disclose an LD spectrometer suitable for determining the isotope ratio, e.g.  $^{13}\text{C}/^{12}\text{C}$ , in a sample gas relative to a reference gas. The sample gas and the reference gas containing the same isotope species in a known isotope ratio are compared to determine the isotope ratio of the sample gas (column 3 lines 13-30 and column 7 lines 48-60). Sauke et al. does not teach or suggest using a reference having an isotope species different from the analyte isotope species for identifying absorption wavelengths of the isotopes for analysis. Further, Sauke et al. could not use a reference gas having a different isotope species from the analyte gas, as the method of Sauke et al. compares the isotope ratio of sample and reference gases to determine the isotope composition of the sample. Applicants respectfully submit that Sauke et al. do not anticipate their invention as claimed and request Examiner to withdraw the rejection on this ground.

Claims 1, 3, 4, 6-8 and 10 are rejected under 35 U.S.C. §102(e) as being anticipated by Higashi (US 5,929,442). Applicants traverse the rejection to the extent that it may be maintained. Claims 3, 5-6 and 10 are cancelled.

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Higashi discloses a method for determining the isotope abundance ratio of  $^{13}\text{CO}_2/^{12}\text{CO}_2$ . Higashi uses the third derivative waveforms of the respective light absorption spectrums of  $^{13}\text{CO}_2$  and  $^{12}\text{CO}_2$  to develop a wavelength discrimination curve that is used to identify frequencies for calculating isotope abundance ratios (column 5 lines 20-37 and column 6 line 60 to column 7 line 48). In one embodiment, Higashi uses a reference cell containing carbon dioxide with a natural abundance of  $^{13}\text{C}/^{12}\text{C}$  to lock the wavelength of a laser diode to the zero crossing points of the third derivative spectrums of  $^{13}\text{CO}_2/^{12}\text{CO}_2$  (column 9 lines 23-56). In other words, Higashi discloses using a reference gas that is the same as the analyte gas for the purpose of locking the wavelength of the laser diode on peak absorption values of the analyte gas for determination of carbon isotope abundance.

In sharp contrast, Applicants' method uses a reference gas different from the analyte gas (carbon dioxide) to provide absorption bands close to (not the same as) the wavelengths of the analyte gas. The absorption wavelengths of the reference gas identify absorption wavelengths of isotopes for analysis, but do not lock the wavelength of the laser diode to absorption wavelengths for analysis. Applicants precisely locate wavelengths of the absorption spectrum for analysis by calculating these wavelengths from the wavelengths of the reference gas nearby to the wavelengths for analysis. Further, Applicants respectfully disagree with Examiner's characterization of the reference gas of Higashi as having two wavelengths close to the wavelengths of absorption spectra of isotopes. The reference gas of Higashi has wavelengths identical to the analyte gas and is used for locking the wavelength of the laser diode on peak absorption values of the analyte gas. Applicants respectfully submit that the method of Higashi does not anticipate the claimed method and respectfully request Examiner to withdraw the rejection of claim 1 on this ground.

With respect to dependent claims 3, 4, 6-8 and 10, claims 3, 6 and 10 are cancelled. It is axiomatic that claims depending from an allowable claim are likewise allowable. Claims 4 and 7 depend from claim 1 and claim 8 depends from claim 4. As submitted above, claim 1 is allowable over Higashi, and therefore, claims 4, 7 and 8 are also allowable. Examiner is respectfully requested to withdraw the rejections on this ground.

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Claims 2, 5 and 9 are rejected under 35 U.S.C. §103(a) as being unpatentable over Higashi (US 5,929,442) in view of Atkinson et al. (US 6,028,310). Applicants traverse the rejection to the extent that it may be maintained. Claims 2, 5 and 9 are cancelled.

Claim 11 is rejected under 35 U.S.C. §103(a) as being unpatentable over Higashi (US 5,929,442) in view of Atkinson et al. (US 6,028,310). Applicants traverse the rejection to the extent that it may be maintained.

The teachings of Higashi are discussed above. Higashi does not teach or suggest a spectroscopic method for analyzing the isotope ratio of carbon dioxide using hydrogen bromide, water, nitrogen oxide and mixtures thereof for identification of the  $^{13}\text{CO}_2/^{12}\text{CO}_2$  isotopes. Atkinson et al. fail to remedy this deficiency. Atkinson et al. disclose a method (infracavity laser spectroscopy or ILS) for detecting low concentrations of gaseous contaminants. Essentially, a laser cavity is provided including an intracavity absorber inside the laser resonator (cavity) and between the reflective mirrors of the resonator. The intracavity absorber may be a sample cell for containing a gaseous sample that is reactive with laser components. The effect of the intracavity gaseous sample on the laser output results in an absorption spectrum of the gaseous species contained within the intracavity absorber (column 8 line 43 to column 9 lines 24 and 50). Atkinson et al. disclose numerous gaseous species including hydrogen bromide that may be detected by their apparatus. Atkinson et al. do not teach or suggest a reference gas to identify isotopes for analysis nor that hydrogen bromide gas is useful for that purpose. Applicants respectfully submit that Higashi in view of Atkinson et al. does not teach or suggest their invention. Examiner is respectfully requested to withdraw the rejections on this ground.

Applicant respectfully submits that claims 1, 4, 7-8 and 11 are allowable over the art of record. Reconsideration and favorable action are respectfully requested. If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicants' primary attorney-of record, Curtis B. Hamre (Reg. No. 29,165), at (612) 336.4722.

Attached hereto is a marked-up version of the changes made to the specification, claims and abstract by the current Amendment. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

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Respectfully submitted,

MERCHANT & GOULD P.C.

P.O. Box 2903

Minneapolis, Minnesota 55402-0903

(612) 332-5300

Dated:

*Jan 9, 2003*

By

*Curtis B. Hamre*  
Curtis B. Hamre

Reg. No. 29,165

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**BEST AVAILABLE COPY**S/N 09/472,585VERSION WITH MARKINGS TO SHOW CHANGES MADEIn the Claims

Please cancel claims 2, 3, 5-6 and 9-10.

Please amend claims 1 and 7 as follows.

1. (AMENDED) A spectroscopic method for analysing isotopes contained in gas to be measured by identifying and quantitatively measuring isotopes by using wavelengths of absorption spectra absorbed in existence of said isotopes, the improvement is characterized in that the method comprises the steps of

using a semiconductor laser beam as a beam source for said wavelengths of said absorption spectra; and

using a reference gas selected from the group consisting of hydrogen bromide, water, nitrogen oxide and mixtures thereof for identification of said isotopes, wherein said reference gas contains collating components having two wavelengths of well-known absorption spectra in wavelength band close to said wavelengths of absorption spectra of said isotopes and said isotopes are isotopes of carbon dioxide gas.

7. (TWICE AMENDED) The spectroscopic method for analyzing isotopes according to claim 1 [3], wherein

said isotopes of carbon dioxide gas as sample gas are  $^{12}\text{CO}_2$  and  $^{13}\text{CO}_2$ , and

said  $^{12}\text{CO}_2$  and  $^{13}\text{CO}_2$  have pairs of following wavelengths

(a wavelength of isotope  $^{12}\text{CO}_2(\text{nm})$ ):(a wavelength of isotope  $^{13}\text{CO}_2(\text{nm})$ )

2054.37	:	2053.96
2044	:	2044.49
2035.34	:	2035.63

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2010.18	:	2010.29
2002.51	:	2002.54
1995.99	:	1996.10

and a abundance ratio is measured by an absorbance in accordance with said a respective pair of wavelengths.

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